

NORTH DAKOTA STATE UNIVERSITY

User's Manual

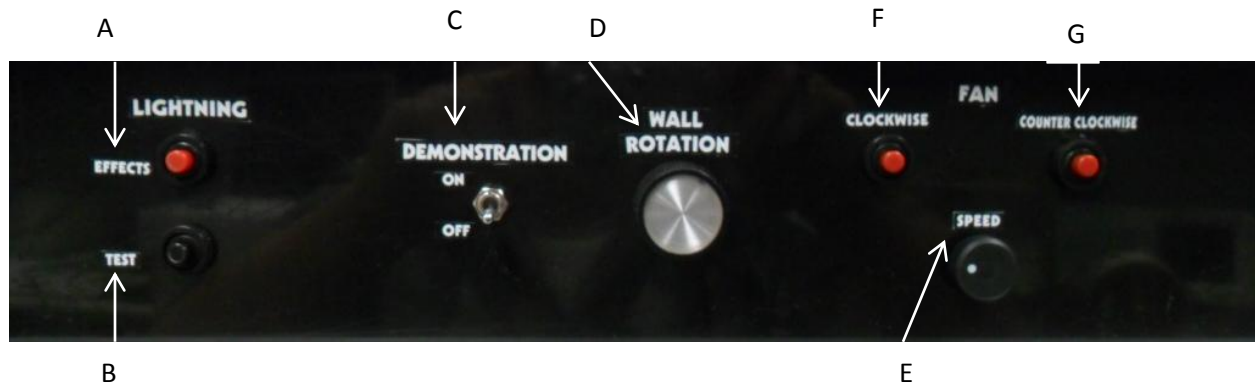
Tornado Simulator

Justin Almen
Nicholas Boldt

Functions:

- Hotplate:
 - Mounted in the bottom
 - Controlled by the switch near the power outlet at the bottom of the case.
 - Used to boil water in the pan to melt dry ice.
- Lightning:
 - Three types of Lightning effects:
 - Ground to Ground: LEDS mounted to the top of the inside of the case.
 - Air to Ground: String of LEDs that flash from top to bottom.
 - Ground to Air: String of LEDS that flash from bottom to top.
- Moving Walls:
 - Adjust airflow into the case.
 - Controls the direction of the tornado.
- Fan:
 - Used to generate airflow in the case. Sucks air out of the case.
 - Two fans that spin in opposite direction. Doesn't matter what direction the fan spins the as long as it sucks air out of the case.
 - Clockwise
 - Counter Clockwise

Controls:



- A. Lightning Effects: Press to turn on the lightning effects. It will run through all 3 different effects randomly until button gets pressed again.
- B. Lightning Test: Press to run through all the lightning Effects once.
- C. Demonstration: Flip switch to on to turn on the demonstration mode. It will run through all the functions until you witch the switch to off.
- D. Wall Rotation: Controls the 4 moving walls. Spin clockwise to spin the walls clockwise. Spin counter clockwise to spin the walls counter clockwise.
- E. Fan Speed: Control the speed of the fan. All the way to the left the fan is not running. All the way to the right the fan is at full speed.
- F. Fan Clockwise: Press and the fan that spins clockwise turn on. Press again to turn it off.
- G. Fan Counter Clockwise: Press and the fan that spins counter clockwise turn on. Press again to turn it off.

Operating the Device:

1. Before plugging in the device check to make sure the pan and the hotplate below the pan is free of debris, also check that the switch on the power socket is flipped to the off state.
2. Plug in the power cord to the socket located on the bottom of the device.
3. Add enough water to the pan to cover the bottom. The Stationary wall directly below the controls can be removed to allow easy access to the center of the device.
4. Turn the switch on top of the power socket to turn on the hot plate.
5. Wait until you can see that the water in the plate has reached a boil.
6. Add dry ice to the center of the device and then replace the wall.
7. Make sure all of the walls are orientated in the same direction. (If you are not sure how to do this turn the wall control in one direction until the walls stop moving)
8. Turn on either of the fans and adjust the speed as desired
9. Give a little bit of time for the tornado to form. If the tornado does not form turn up the fan and recheck that the walls are rotated correctly.

Troubleshooting:

1. Hot Plate

- a) To set desired temperature.
 - i. Tip Machine over on its side.
 - ii. Reach under to get to the dial on the hot plate.
 - iii. Turn temperature up or down until you get your desired temperature.

2. The case has been damaged

a) Aluminum Frames

- i. To take apart of the aluminum frames use an $\frac{5}{32}$ nd allen wrench.
- ii. Connectors are located at joints where frame pieces meet up.
- iii. To replace any frame pieces order replacement from any 80/20 modular erectors set distributors (<http://8020.net/>) to get the desired length you need.

b) Clear Polycarbonate Walls

- i. The current walls are clear polycarbonate sheets that are $\frac{1}{4}$ inch thick.
- ii. Sizes

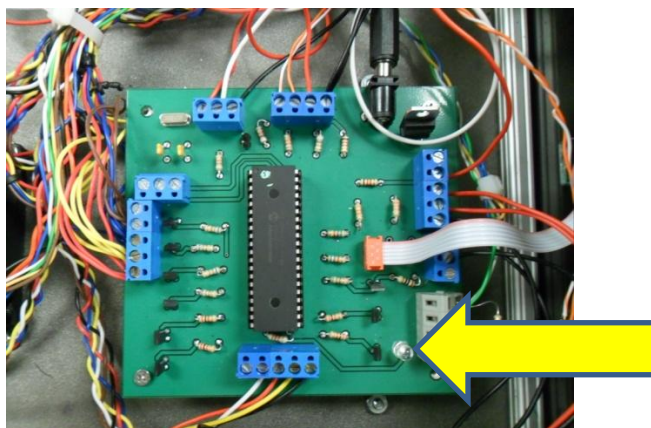
- Stationary walls: 6"x 33.5"
 - Moving walls: 7"x 33.375"
- iii. New walls can be order at <http://www.interstateplastics.com/> if new ones are required.

c) Paneling

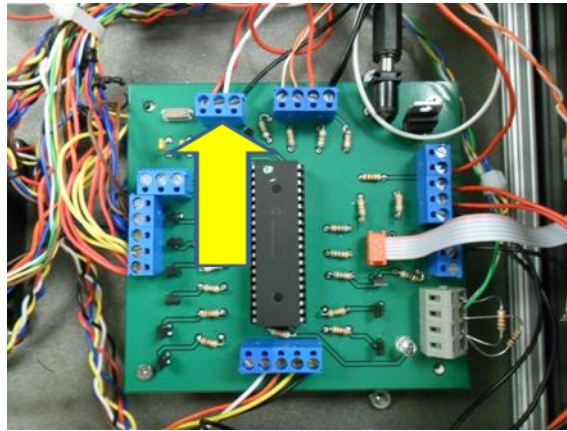
- i. Panels slide in and out of grove.
- ii. The thicknesses of panel are $\frac{3}{16}$ ".
- iv. If new panel are needed they can also be order at <http://www.interstateplastics.com/>.

3. Nothing happens when the device is plugged in

- a) Carefully turn the device on its side and remove the cover that is in the corner of the bottom of the device.
- b) Check that the light on the power supply turns on when the device is plugged in. If it does not light up check connections from the jack on the outside of the device to the power supply. If these connections are ok the power supply will need to be replaced.
- c) If the light on the power supply turns on check the connections of the two wires that run from the corner of the case along the side.
- d) Set the device back up vertically on its feet and remove one of the corner braces. Slide out the top piece of plastic to expose the electronics.
- e) Make sure the device is powered and look for the LED that is on the green PCB. If it is flashing on and off steadily every second refer to sections 4, 5 and 6 of the troubleshooting guide. If the LED flashes erratically very fast or stays completely on refer to section 8. If the LED does not light continue to step f of this section.



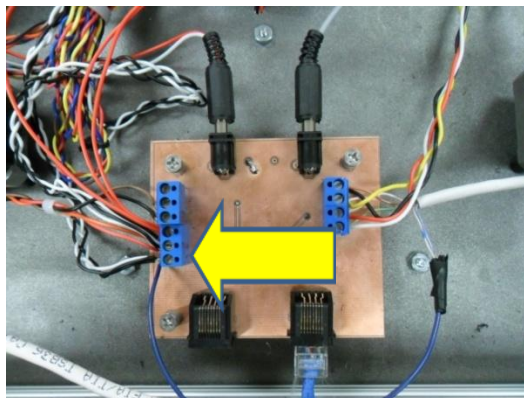
- f) Find the cord that comes out of the corner of the device and runs along the length. Unplug this cord from the PCB it is plugged in to and test that it is supplying 12V DC. If it is not at 12V recheck the power supply and then replace the cord.
- g) Check the cord that runs between the two sockets on each of the PCBs when unplugged from the green PCB it should read 12V.
- h) Check that the voltage on the green PCB is at 5V. An easy place to check this is the three position terminal next to the crystal, The voltage should read 5V between the two outside connections of this terminal.



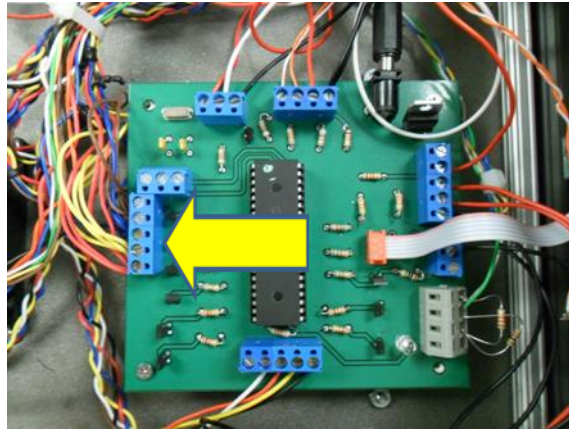
- i) If all of these voltages are read correctly refer to section 8.

4. The walls do not turn correctly

- a) Check that the bottom and top of the wall, so they can freely move. The four rotating walls should be able to rotate with very little resistance
- b) Open the top of the case and look for the LED on the green PCB. If the LED is not flashing steadily every second refer to section 8 of this troubleshooting guide.
- c) The black and white wires from the motors should be connected to the copper PCB in the terminal A.

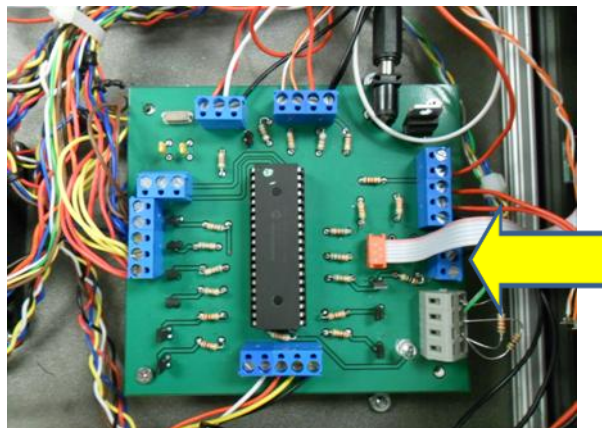


- d) The red, yellow, blue and brown wires should be connected to the terminal on the green PCB that is facing the fan. When looking from the direction of the control panel the wires should be connected in the order red, yellow, blue then brown from left to right

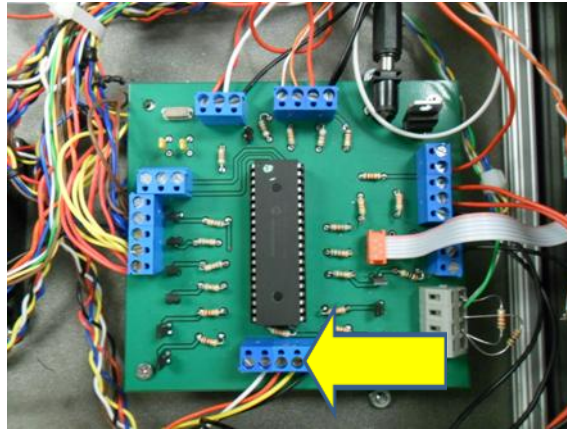


5. The LED's do not flash correctly

- a) Open the top of the case and look for the LED on the green PCB. If the LED is not flashing steadily every second refer to section 8 of this troubleshooting guide.
- b) If the LEDs connected next to the fan are not working correctly find the two leads that are connected to each of the LEDs. The black lead should be connected to the middle connection of the 3 position terminal facing the control panel. The red leads should be connected to copper PCB in the terminal A.

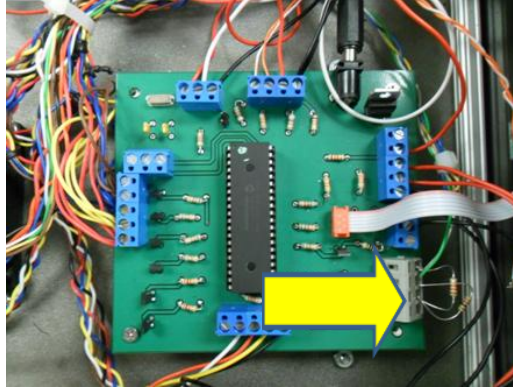


- c) If the yellow string LEDs do not work correctly look for the two lengths of Cat 5 cable that run from the corners on top of the device. These two wires should be connected firmly to the two Jacks on the copper PCB. If the cables are connected securely to the copper PCB look for the red, yellow, black and white wires that run from the copper PCB to the green PCB. These wires should be connected to the terminals facing away from the control panel on the copper PCB and to the terminals facing left when looking from the control panel on the green PCB.



6. The fan does not operate correctly

- a) Check that both fans are free of debris and spin freely.
- b) Open the top of the case and look for the LED on the green PCB. If the LED is not flashing steadily every second refer to section 8 of this troubleshooting guide.
- c) If one or both of the fans turn completely on when the device is powered look for the green and white wires coming from the fan. These wires should be connected to the terminal that is in the bottom left corner of the green PCB when facing from the direction of the control panel. The white and green wires should be connected to the 3rd and 4th connections on this terminal from left to right. Also 1k resistors should be connected from the 3rd and 4th terminal to the 2nd terminal.



- d) If either of the fans does not turn on find the red, orange, brown and black wires coming from the fan. The red and orange wires should be connected to the terminal A of the copper PCB to side that is fully pressed into the board. The brown and red wires should be connected to the raised connection of this terminal.

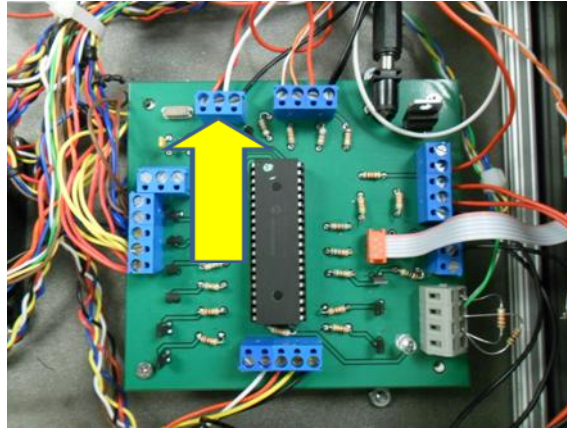
7. The demonstration mode does not operate correctly

- a) Test that both of the fans work correctly by turning one fan on and then the other. If either of the fans does not work properly refer to section 6. After this make sure both of the fans are off when testing the demonstration mode.
- b) Test that the walls rotate properly when the demonstration mode is off. If they do not work refer to section 4.
- c) Test that the LEDs work properly when the demonstration mode is off. If they do not work refer to section 5.
- d) After checking these three functions refer to section 8 for further help.

8. Problem with the controller

- a) If you have not done so already open the top of the case and with a multi-meter check that the plug running from the copper PCB to the green PCB is at 12V DC when the device is plugged in. If it is not refer to section 3.

- b) Check that the voltage on the green PCB is at 5V. An easy place to check this is the three position terminal next to the crystal. The voltage should read 5V between the two outside connections of this terminal.



- c) Find the leads that come from the switches on the control panel. Test that all of these leads are connected securely to the green PCB.
- d) While the device is plugged in briefly short the two terminals that are directly to the right of the microcontroller when looking from the direction of the control panel. This should reset the controller. If the LED on the board does not start to flash steadily every second continue on with this guide.
- e) Check that the controller is firmly placed in its socket. There should be no give when the controller is pressed directly into the board.
- f) Carefully replace the controller with the backup controller that is provided
- g) Carefully remove the PCB from the device and check that all of the connections are soldered correctly